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Progress Report No. 3

Report Period: 19 March 1966 to 18 April 1966

Project Title: Gems Development (continuation)

PROJECT IDENTIFICATION

Contractor's Project No. . . . . .SPO 27203

Customer's Project No. 99740-6

Contract No. . . . . [redacted] STAT
Dated: 5 January 1966

FISCAL DATA

Type of Contract	CPFF
Total Contract Price	[redacted] STAT
Scheduled Completion Date	30 June 1967
Percent of Total Funds Expended	10.4% as of 25 Apr. 1966
Percent of Work Completed	10.4% as of 25 Apr. 1966

Objective of Project

The principal objective of this project is to determine how well the image quality of mission photography can be assessed by means of Gems. In order to accomplish this objective, psychological tests shall be performed wherein photographic images of known quality (Gems) are compared to mission photography. In fulfillment of this objective, a number of subtasks are being undertaken. These subtasks consist in the refinement of existing Gem making techniques, the study of alternate techniques, the study of Gems viewing equipment, and the preparation of Gem sets in large numbers.

Status of Overall Project

During the third month of this program, the expansion of the photographic facility was completed with the exception of the installation of sinks and cabinets in the second darkroom. This portion of the expansion has been delayed approximately three (3) weeks because of procurement difficulties. In the area of special equipment essential to the production of Gems, good progress has been made. A modification to the light source assembly of the breadboard Gems maker has been completed and tested. The tests demonstrate that much shorter exposure times will now be required in the preparation of Gems. This design improvement is now being implemented in a second Gems maker. This equipment together with the expanded photographic facility will provide the means to satisfy all of the Gems production requirements on this program.

The progress on the various subtasks is given below. In most instances, the work on each subtask has either just begun or is about to be started. One notable exception is the analysis of physical limitations inherent in the Gems making procedure. The results of this analysis which take into account near field effects are given in this report.

Work Completed During Report Period

a) Equipment Modification

The modification to the source assembly of the Gems maker affected an even greater reduction in exposure time then had been anticipated. Tests with positive type film (blue sensitive) show a reduction in exposure time by a factor of approximately 30. It appears that the bromine cycle lamp is spectrally more efficient then the tungsten source in the blue region of the spectrum. This spectral effeciency probably explains why exposure times can be reduced by a factor of 30 as opposed to the factor of 3 that had been expected. In the exposure of negative type film, we should not expect an equally favorable result. However, a tenfold reduction in exposure time might not be unreasonable. A comparative analysis of the two exposure conditions is given in Figure 1 attached. The sensitometric curves produced in each case are the result of equivalent exposure times and near identical processing.

b) Near Field Effects in Gem Making

In the preparation of Gems by the modified printing technique, a separation is introduced between the transparency and the film being exposed. Under these conditions, the illumination of the transparency can give rise to diffraction images in the film plane. To date, these effects have been neglected in the prediction of the image formed in the film plane.

The formation of diffraction images in the film plane has been examined analytically. In this analysis, a perfect knife edge image is assumed to exist in the plane of the transparency. Furthermore, the source which illuminates this transparency is assumed to have a Gaussian distribution in intensity. At this point, the formation of the image in the film plane is determined according to two mechanisms. (1) - The rectilinear propagation of the source distribution and (2) the near field diffraction image. This analysis was carried out for several spacings of film and transparency such that the quality of the image (neglecting near field effects) plane was expected to progress from a cutoff frequency of 50 cycles per mm to 400 cycles per mm. The results of this analysis are given in Figures 2 through 9. In each of the cases evaluated, the Gaussian edge-image predicted on the assumption of no near field effects is given. Also in each case, a second edge image is shown which image includes the effects of near field diffraction.

The cases evaluated provide a good insight into the importance of near field effects. It is apparent in the case of the 50 cycle per mm condition that near field effects are negligible. On the other hand, near field effects are clearly the dominant factor in the formation of images in the range of 200 to 400 cycles per mm. The spatial frequency at which near field effects limit the usefulness of this Gems making technique is not precisely identified by this analysis, but there is a good indication that the technique should prove useful out to approximately 100 cycles per mm. In that case, Figure 3, the near field effects are apparent but are not dominant. In practice, the near field effects would never be as strong as this analysis indicates since the transparencies from which Gems are produced are not in themselves knife edge images.

c) Psychophysical Testing

The subcontract in the area of psychophysical testing has been established. A preliminary meeting was held at the customer's facility during the week of 28 March. It is anticipated that a second meeting will occur again at the customer's facility during the week of 25 April. The objective of this second meeting will be the establishment of the specifications for a Gems Set to be employed in the psychophysical study. Once these specifications are agreed upon, the schedule for preparing the required Gems material will be re-examined.

d) Gems Viewer

An American Optical Split Field Microscope Comparater has been ordered with delivery scheduled for 15 June. It is our intention to perform a design study on the requirements of a Gems Viewer built around this device. This subtask has been assigned to [redacted] as lead engineer. STATINTL

Work for Next Period

The specific activity for the next period will include:

a) Completion of the photographic facility and all associated equipment.

b) Specification of Gems for Psychophysical Testing.

c) Planning of Gems Viewer Study.

d) Initiation of study on alternate Gems making technique.

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Figure 1
Characteristic Curves for 8430 Film
Processed in D-76, 4', 68°F
Constant Agitation
Exposed in Gem Machine with 270° Mask
Mask Height 18.5"
Exposure Time
A = 40 minutes, .30 N.D. Filter in System,
300 Watt Tungsten Bulb, 120V

B = 20 minutes, no Filter
650 W., Quartz - Bromine Bulb, 120V

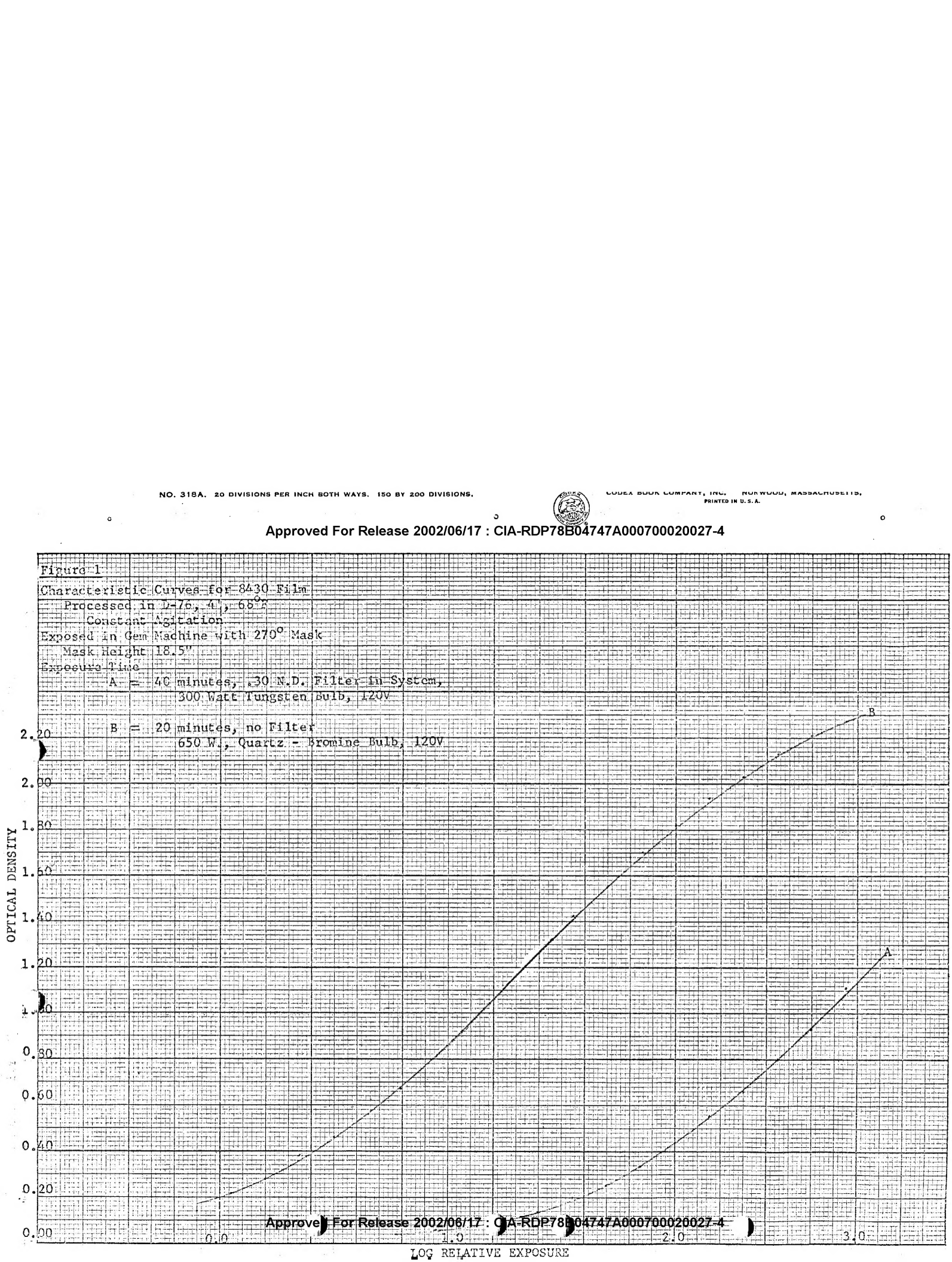


FIG. 2

NEAR FIELD EFFECT

CASE A (K_μ = 50 cy./mm)

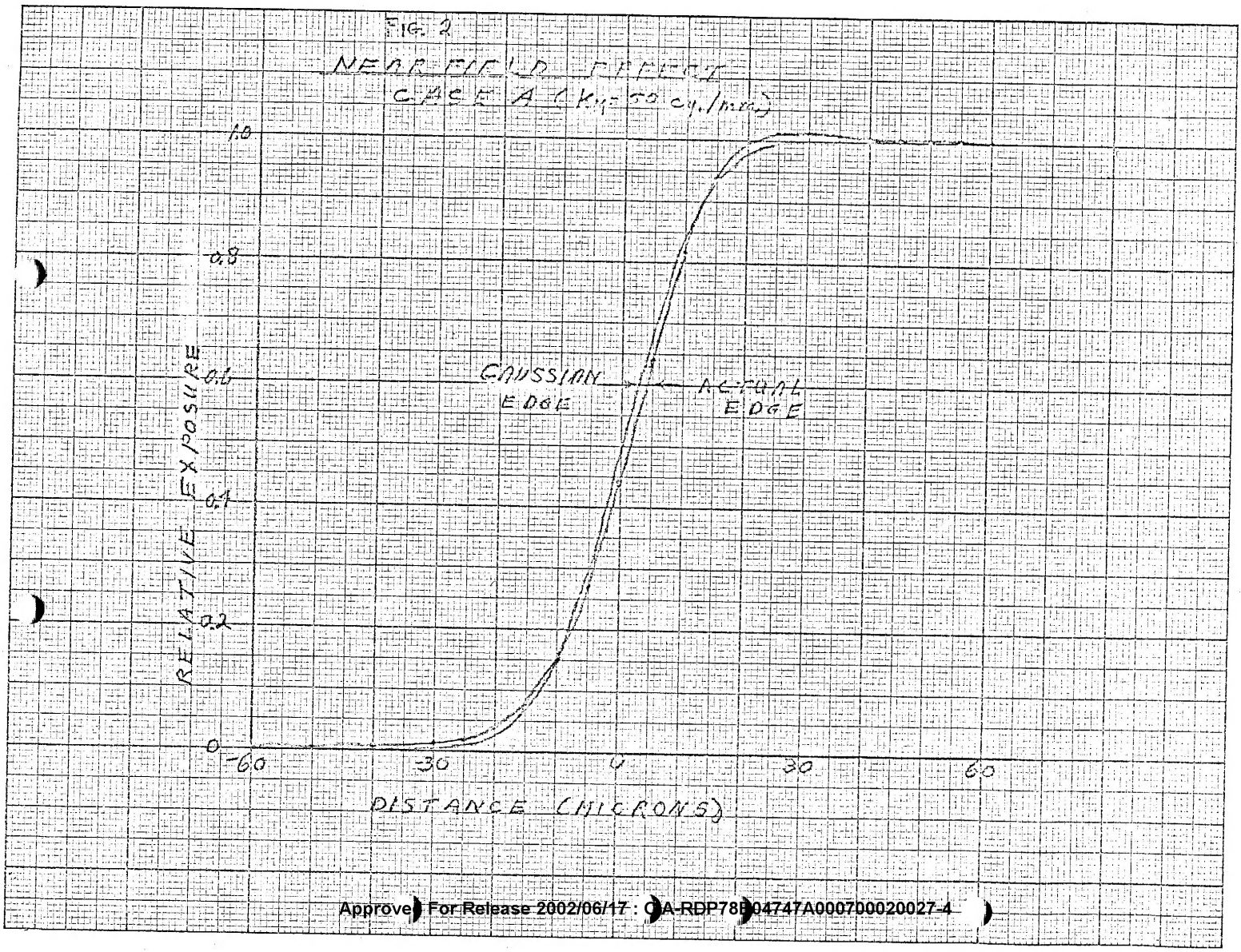


FIG. 3

NEAR FIELD EFFECT

CASE B (K_m = 100 cy/mm)

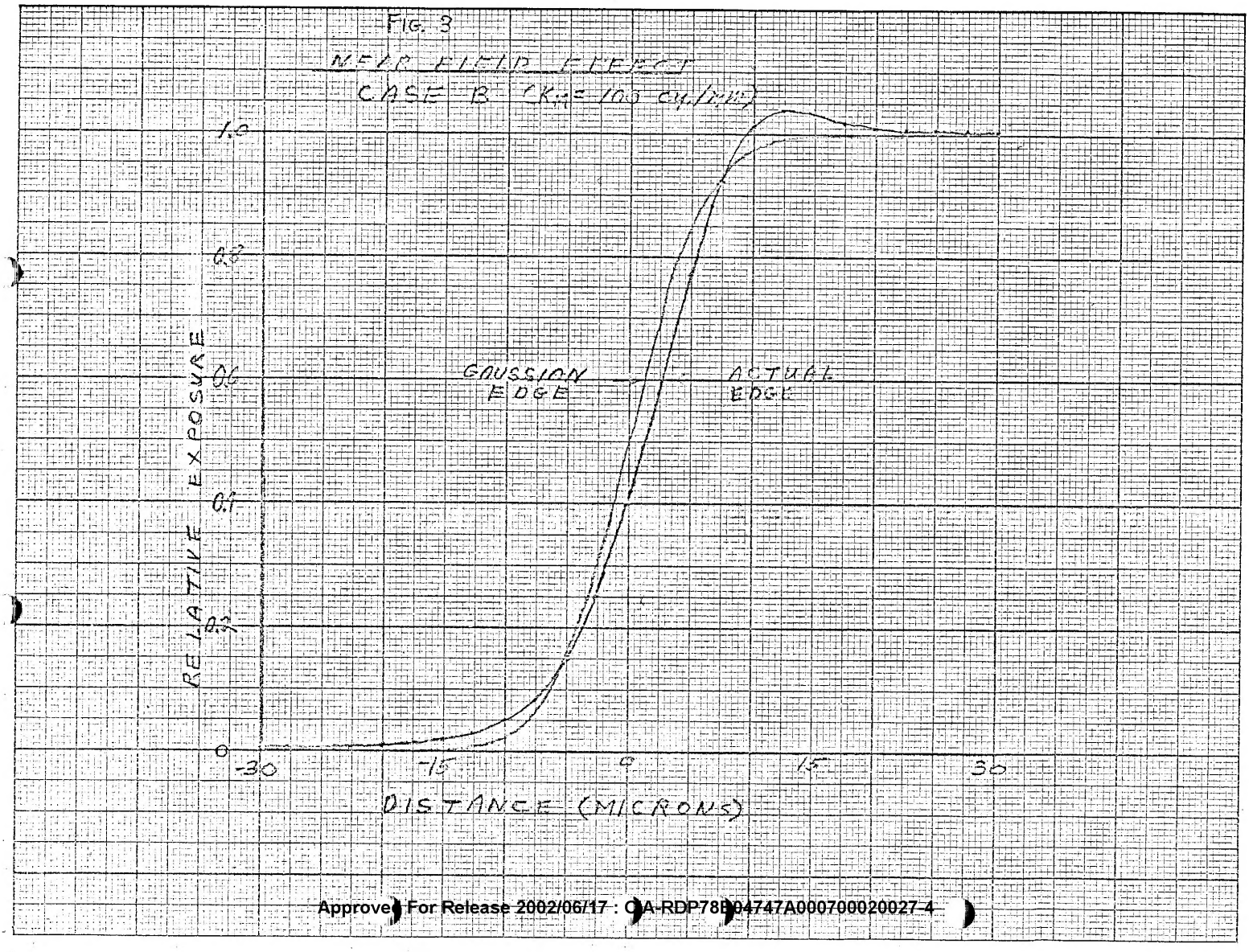


FIG. 4
NEAR-FIELD EFFECT
CASE C (KNO3 150 cal/mm)

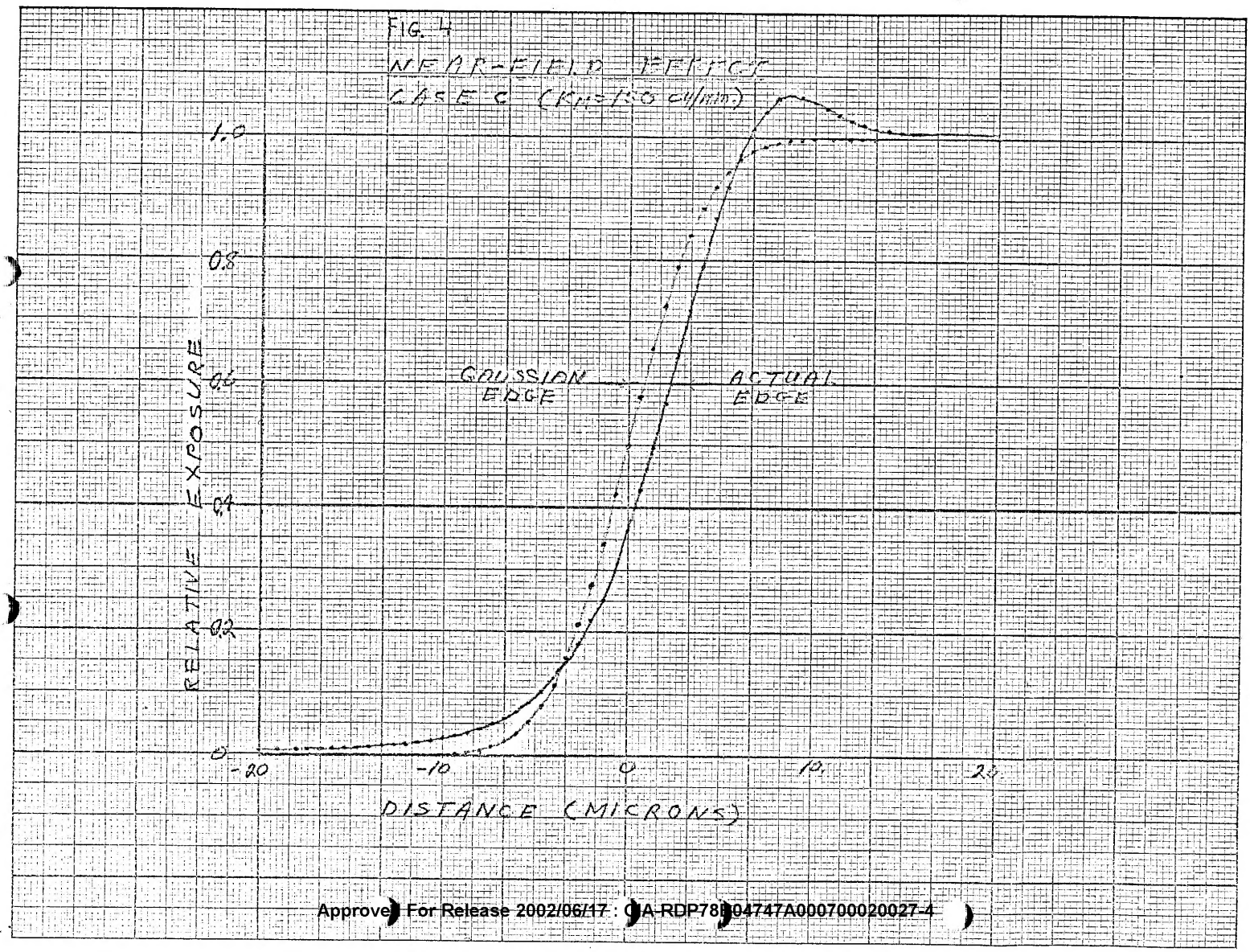
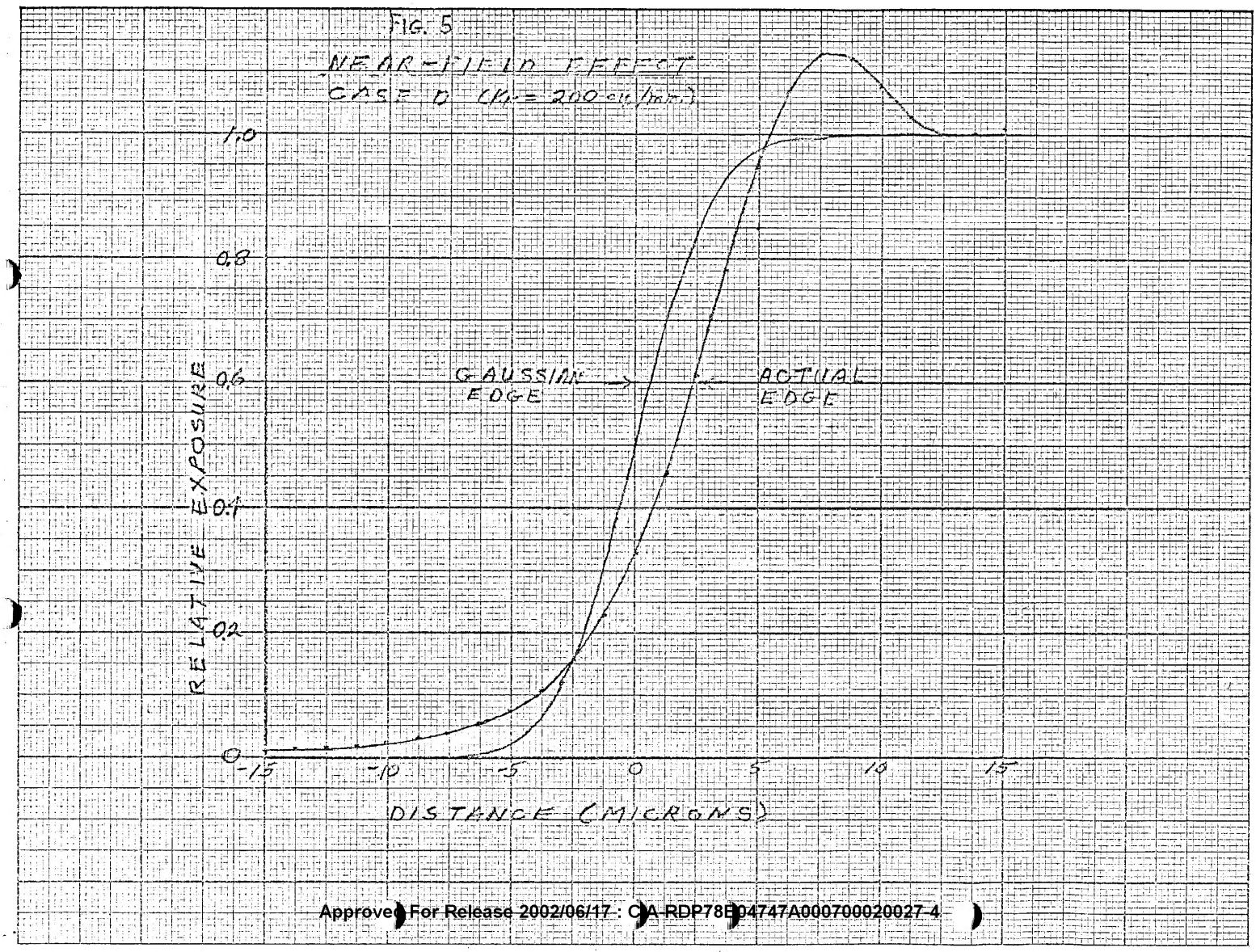
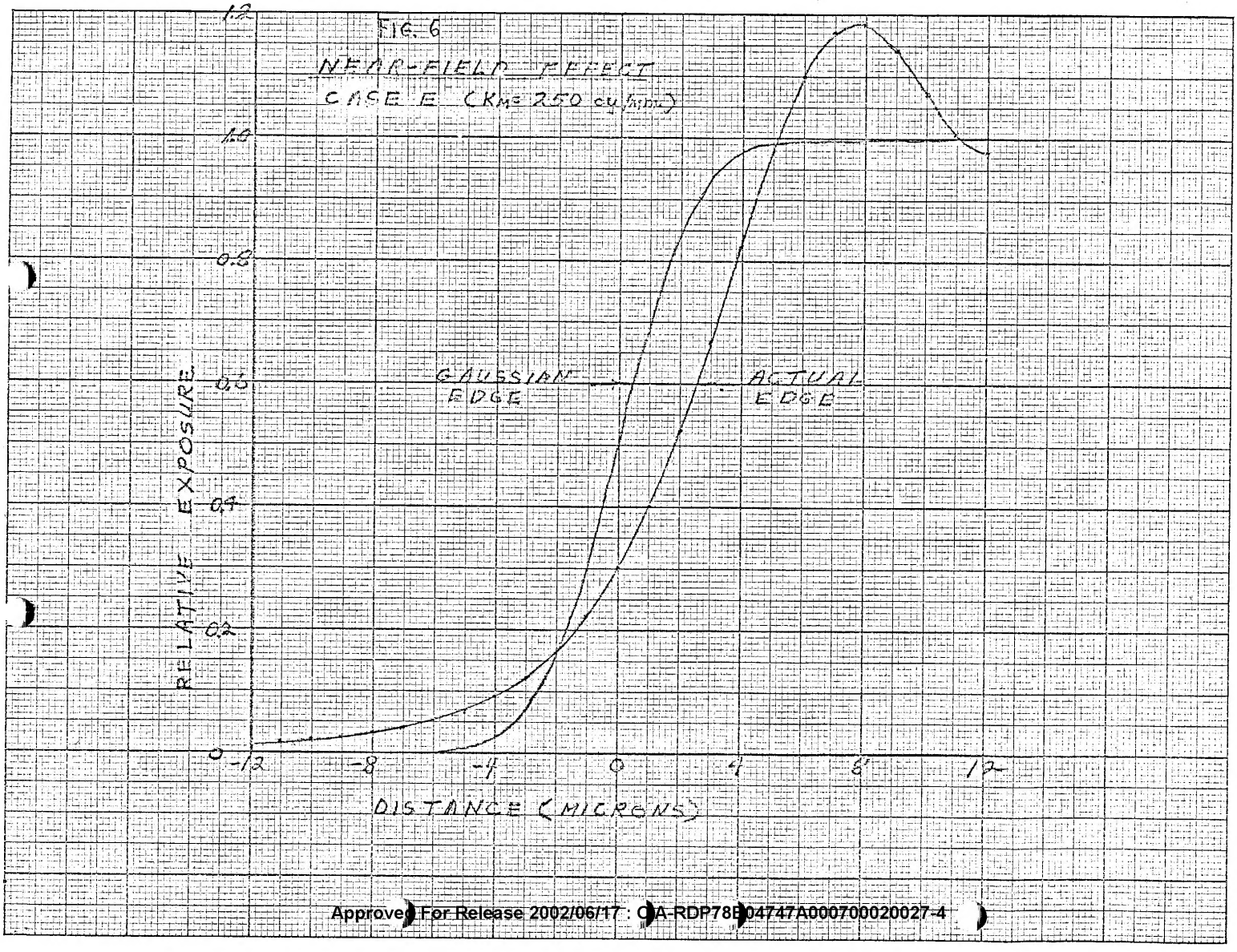


FIG. 5

NEAR-FIELD EFFECT

CASE D (R_f = 200 cycles/mm)





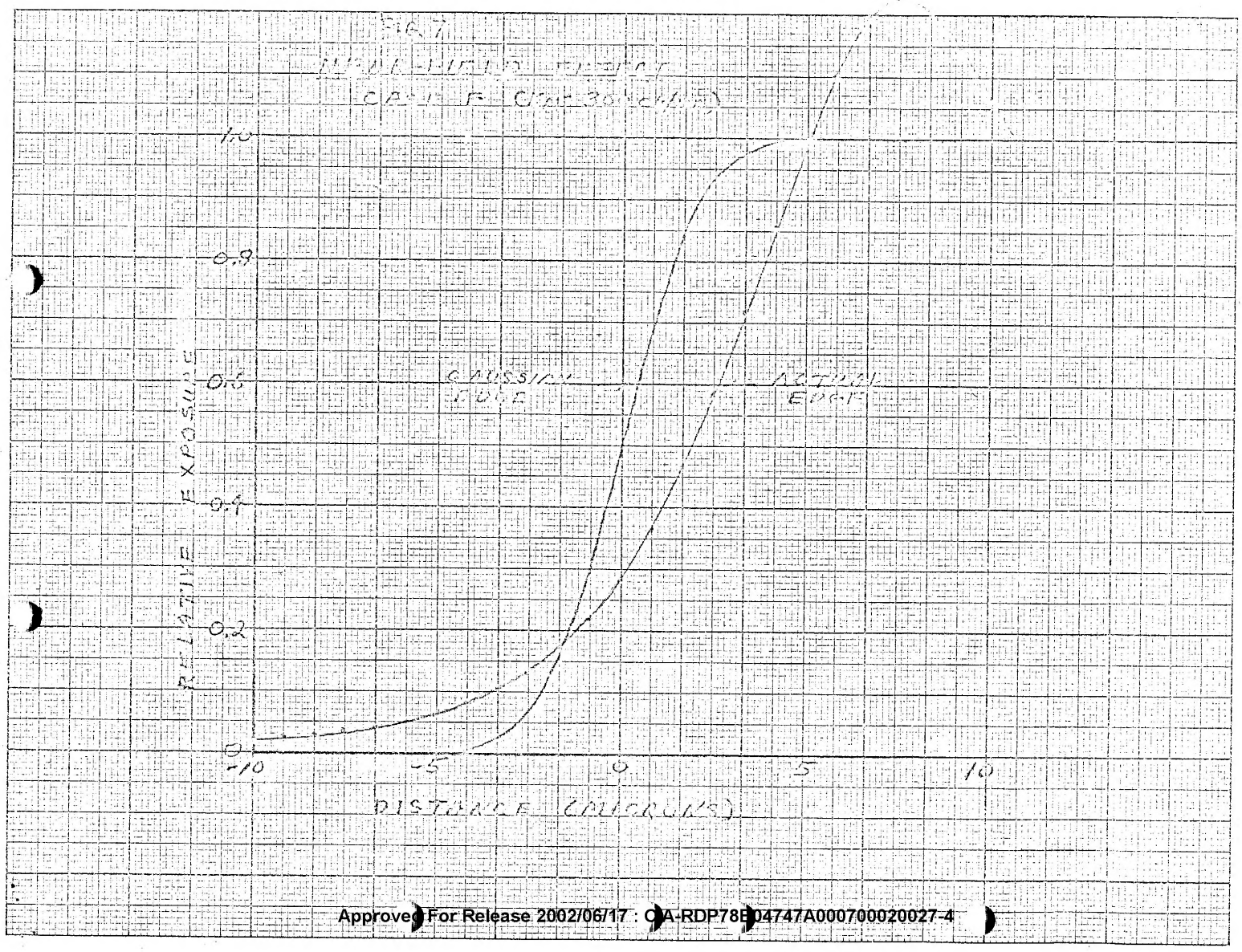


FIG. 8

NEAR-FIELD EFFECT

CASE G (KM = 350 cu/mm)